

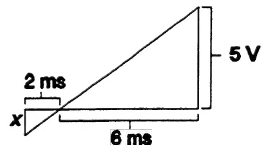
CHAPTER 13 (Odd)

1. a. $T = 18 \text{ ms} - 8 \text{ ms} = 10 \text{ ms}$

b. 2 cycles

c. $f = \frac{1}{T} = \frac{1}{10 \times 10^{-3} \text{ s}} = 0.1 \times 10^3 \text{ Hz} = 100 \text{ Hz}$

d. Amplitude = 5 V



$$\frac{2 \text{ ms}}{x} = \frac{6 \text{ ms}}{5 \text{ V}}$$

$$x = \frac{5}{6}(2 \text{ V}) = 1.67 \text{ V}$$

$$V_{p-p} = 5 \text{ V} + 1.67 \text{ V} = 6.67 \text{ V}$$

3. $T = 26 \text{ ms} - 16 \text{ ms} = 10 \text{ ms}$

$$f = \frac{1}{T} = \frac{1}{10 \text{ ms}} = 100 \text{ Hz}$$

5. a. $f = \frac{1}{T} = \frac{1}{1/60 \text{ s}} = 60 \text{ Hz}$

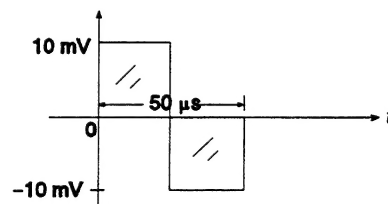
b. $f = \frac{1}{T} = \frac{1}{0.01 \text{ s}} = 100 \text{ Hz}$

c. $f = \frac{1}{34 \times 10^{-3} \text{ s}} = 29.41 \text{ Hz}$

d. $f = \frac{1}{25 \times 10^{-6} \text{ s}} = 40 \text{ kHz}$

7. $T = \frac{1}{20 \text{ Hz}} = 0.05 \text{ s}, 5(0.05 \text{ s}) = 0.25 \text{ s}$

9. $T = \frac{1}{20 \text{ kHz}} = 50 \mu\text{s}$



11. a. $(45^\circ) \left[\frac{\pi}{180^\circ} \right] = 0.25\pi = \frac{\pi}{4} \text{ rad}$

b. $(60^\circ) \left[\frac{\pi}{180^\circ} \right] = \frac{\pi}{3} \text{ rad}$

c. $(120^\circ) \left[\frac{\pi}{180^\circ} \right] = \frac{2}{3}\pi \text{ rad}$

d. $(270^\circ) \left[\frac{\pi}{180^\circ} \right] = \frac{3}{2}\pi \text{ rad}$

e. $(178^\circ) \left[\frac{\pi}{180^\circ} \right] = 0.989\pi \text{ rad}$

f. $(221^\circ) \left[\frac{\pi}{180^\circ} \right] = 1.228\pi \text{ rad}$

13. a. $\omega = \frac{2\pi}{T} = \frac{2\pi}{2 \text{ s}} = 3.14 \text{ rad/s}$

b. $\omega = \frac{2\pi}{0.3 \times 10^{-3} \text{ s}} = 20.94 \times 10^3 \text{ rad/s}$

- c. $\omega = \frac{2\pi}{4 \times 10^{-6} \text{ s}} = 1.57 \times 10^6 \text{ rad/s}$ d. $\omega = \frac{2\pi}{1/25 \text{ s}} = 157.1 \text{ rad/s}$
15. a. $\omega = 2\pi f = \frac{2\pi}{T} \Rightarrow f = \frac{\omega}{2\pi}$
 $T = \frac{2\pi}{\omega} = \frac{1}{f}$
 $f = \frac{\omega}{2\pi} = \frac{754 \text{ rad/s}}{2\pi} = 120 \text{ Hz}, T = 8.33 \text{ ms}$
- b. $f = \frac{\omega}{2\pi} = \frac{8.4 \text{ rad/s}}{2\pi} = 1.34 \text{ Hz}, T = 746.27 \text{ ms}$
- c. $f = \frac{\omega}{2\pi} = \frac{6000 \text{ rad/s}}{2\pi} = 954.93 \text{ Hz}, T = 1.05 \text{ ms}$
- d. $f = \frac{\omega}{2\pi} = \frac{1/16 \text{ rad/s}}{2\pi} = 9.95 \times 10^{-3} \text{ Hz}, T = 100.5 \text{ ms}$
17. $(30^\circ) \left[\frac{\pi}{180^\circ} \right] = \frac{\pi}{6}, \alpha = \omega t \Rightarrow \omega = \frac{\alpha}{t} = \frac{\pi/6}{5 \times 10^{-3} \text{ s}} = 104.7 \text{ rad/s}$
23. $i = 0.5 \sin 72^\circ = 0.5(0.9511) = 0.4755 \text{ A}$
25. $6 \times 10^{-3} = 30 \times 10^{-3} \sin \alpha$
 $0.2 = \sin \alpha$
 $\alpha = \sin^{-1} 0.2 = 11.537^\circ \text{ and } 180^\circ - 11.537^\circ = 168.463^\circ$
29. a. v leads i by 10° b. i leads v by 70°
c. i leads v by 80° d. i leads v by 150°
31. a. $\left[\frac{\pi}{6} \right] \left[\frac{180^\circ}{\pi} \right] = 30^\circ, \omega = 2\pi f = 377 \text{ rad/s}$
 $v = 25 \sin(\omega t + 30^\circ)$
- b. $\pi - \frac{2}{3}\pi = \frac{\pi}{3} = 60^\circ, \omega = 2\pi f = 6.28 \times 10^3 \text{ rad/s}$
 $i = 3 \times 10^{-3} \sin(6.28 \times 10^3 t - 60^\circ)$
33. $T = \frac{1}{f} = \frac{1}{1000 \text{ Hz}} = 1 \text{ ms}$
 $t_1 = \frac{120^\circ}{180^\circ} \left[\frac{T}{2} \right] = \frac{2}{3} \left[\frac{1 \text{ ms}}{2} \right] = \frac{1}{3} \text{ ms}$
35. $\omega = \frac{2\pi}{T} \Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{1800} = 3.49 \text{ ms}$
 $t_1 = \frac{40^\circ}{180^\circ} \left[\frac{T}{2} \right] = 0.222 \left[\frac{3.49 \text{ ms}}{2} \right] = 0.388 \text{ ms}$

37. a. $T = (2 \text{ div.})(0.2 \text{ ms/div.}) = 0.4 \text{ ms}$

b. $f = \frac{1}{T} = \frac{1}{0.4 \text{ ms}} = 2.5 \text{ kHz}$

c. $\text{Average} = (-2.5 \text{ div.})(10 \text{ mV/div.}) = -25 \text{ mV}$

d. —

39. a.
$$G = \frac{\frac{1}{2}(3 \text{ s})(10 \text{ V}) + \frac{1}{2}(2 \text{ s})(10 \text{ V}) - \frac{1}{2}(2 \text{ s})(10 \text{ V})}{8 \text{ s}}$$

$$= \frac{15 \text{ V} + 10 \text{ V} - 10 \text{ V}}{8} = 1.875 \text{ V}$$

b.
$$G = \frac{\frac{1}{2} \left[\frac{\pi}{2} \right] (10 \text{ mA}) - 2(15 \text{ mA}) - \frac{\pi}{2} (5 \text{ mA})}{2\pi}$$

$$= \frac{2.5\pi \text{ mA} - 30 \text{ mA} - 2.5\pi \text{ mA}}{2\pi}$$

$$= \frac{-30 \text{ mA}}{2\pi} = -4.775 \text{ mA}$$

41. a. $T = (4 \text{ div.})(10 \text{ } \mu\text{s/div.}) = 40 \text{ } \mu\text{s}$

b. $f = \frac{1}{T} = \frac{1}{40 \text{ } \mu\text{s}} = 25 \text{ kHz}$

(c)
$$G = \frac{(2.5 \text{ div.})(1.5 \text{ div.}) + (1 \text{ div.})(0.5 \text{ div.}) + (1 \text{ div.})(0.6 \text{ div.}) + (2.5 \text{ div.})(0.4 \text{ div.}) + (1 \text{ div.})(1 \text{ div.})}{4 \text{ div.}}$$

$$= \frac{3.75 \text{ div.} + 0.5 \text{ div.} + 0.6 \text{ div.} + 1 \text{ div.} + 1 \text{ div.}}{4}$$

$$= \frac{6.85 \text{ div.}}{4} = 1.713 \text{ div.}$$

$$1.713 \text{ div.}(10 \text{ mV/div.}) = 17.13 \text{ mV}$$

43. a. $2 \sin 377t$

b. $100 \sin 377t$

c. $84.87 \times 10^{-3} \sin 377t$

d. $33.95 \times 10^{-6} \sin 377t$

45.
$$V_{\text{eff}} = \sqrt{\frac{(3 \text{ V})^2(2 \text{ s}) + (2 \text{ V})^2(2 \text{ s}) + (1 \text{ V})^2(2 \text{ s}) + (-1 \text{ V})^2(2 \text{ s}) + (-3 \text{ V})^2(2 \text{ s}) + (-2 \text{ V})^2(2 \text{ s})}{12 \text{ s}}}$$

$$= +2.16 \text{ V}$$

47.
$$G = \frac{(10 \text{ V})(5 \text{ } \mu\text{s}) - (10 \text{ V})(5 \text{ } \mu\text{s}) + 0}{15 \text{ } \mu\text{s}} = \frac{0 + 0}{15 \text{ } \mu\text{s}} = 0 \text{ V}$$

$$V_{\text{eff}} = \sqrt{\frac{(10 \text{ V})^2 5 \text{ } \mu\text{s} + (-10 \text{ V})^2 5 \text{ } \mu\text{s} + 0}{15 \text{ } \mu\text{s}}} = 8.165 \text{ V}$$

49. a. $T = (4 \text{ div.})(10 \mu\text{s/div.}) = 40 \mu\text{s}$

$$f = \frac{1}{T} = \frac{1}{40 \mu\text{s}} = 25 \text{ kHz}$$

$$\text{Av.} = (1 \text{ div.})(20 \text{ mV/div.}) = 20 \text{ mV}$$

$$\text{Peak} = (2 \text{ div.})(20 \text{ mV/div.}) = 40 \text{ mV}$$

$$\text{Effective} = \sqrt{V_0^2 + \frac{V_{\max}^2}{2}} = \sqrt{(20 \text{ mV})^2 + \frac{(40 \text{ mV})^2}{2}} = 34.641 \text{ mV}$$

b. $T = (2 \text{ div.})(50 \mu\text{s}) = 100 \mu\text{s}$

$$f = \frac{1}{T} = \frac{1}{100 \mu\text{s}} = 10 \text{ kHz}$$

$$\text{Av.} = (-1.5 \text{ div.})(0.2 \text{ V/div.}) = -0.3 \text{ V}$$

$$\text{Peak} = (1.5 \text{ div.})(0.2 \text{ V/div.}) = 0.3 \text{ V}$$

$$\text{Effective} = \sqrt{V_0^2 + \frac{V_{\max}^2}{2}} = \sqrt{(.3 \text{ V})^2 + \frac{(.3 \text{ V})^2}{2}} = 367.42 \text{ mV}$$

CHAPTER 13 (Even)

2. a. $T = 15 \mu\text{s}$ b. $2\frac{1}{3}$ cycles
- c. $f = \frac{1}{T} = \frac{1}{15 \mu\text{s}} = 66.7 \text{ kHz}$ d. Positive amplitude = 10 V, $V_{p-p} = 20 \text{ V}$
4. a. $T = \frac{1}{25 \text{ Hz}} = 40 \text{ ms}$ b. $T = \frac{1}{35 \times 10^6 \text{ Hz}} = 28.57 \text{ ns}$
- c. $T = \frac{1}{55 \times 10^3 \text{ Hz}} = 18.18 \mu\text{s}$ d. $T = \frac{1}{1 \text{ Hz}} = 1 \text{ s}$
6. $T = \frac{24 \text{ ms}}{80 \text{ cycles}} = 0.3 \text{ ms}$
8. $f = \frac{42 \text{ cycles}}{6 \text{ s}} = 7 \text{ Hz}$
10. a. $V_{\text{peak}} = (3 \text{ boxes})(50 \text{ mV/box}) = 150 \text{ mV}$ b. $T = (4 \text{ boxes})(10 \mu\text{s/box}) = 40 \mu\text{s}$
- c. $f = \frac{1}{T} = \frac{1}{40 \mu\text{s}} = 25 \text{ kHz}$
12. a. $\left(\frac{\pi}{4}\right) \left(\frac{180^\circ}{\pi}\right) = 45^\circ$ b. $\left(\frac{\pi}{6}\right) \left(\frac{180^\circ}{\pi}\right) = 30^\circ$
- c. $\left(\frac{\pi}{10}\right) \left(\frac{180^\circ}{\pi}\right) = 18^\circ$ d. $\left(\frac{7\pi}{6}\right) \left(\frac{180^\circ}{\pi}\right) = 210^\circ$
- e. $(3\pi) \left(\frac{180^\circ}{\pi}\right) = 540^\circ$ f. $(0.55\pi) \left(\frac{180^\circ}{\pi}\right) = 99^\circ$
14. a. $\omega = 2\pi f = 2\pi(50 \text{ Hz}) = 314.16 \text{ rad/s}$
- b. $\omega = 2\pi f = 2\pi(600 \text{ Hz}) = 3769.91 \text{ rad/s}$
- c. $\omega = 2\pi f = 2\pi(2 \text{ kHz}) = 12.56 \times 10^3 \text{ rad/s}$
- d. $\omega = 2\pi f = 2\pi(0.004 \text{ MHz}) = 25.12 \times 10^3 \text{ rad/s}$
16. $(45^\circ) \left(\frac{\pi}{180^\circ}\right) = \frac{\pi}{4} \text{ radians}$
- $$t = \frac{\theta}{\omega} = \frac{\pi/4 \text{ rad}}{2\pi f} = \frac{\pi/4 \text{ rad}}{2\pi(60 \text{ Hz})} = \frac{1}{(8)(60)} = \frac{1}{480} = 2.08 \text{ ms}$$

18. a. Amplitude = 20, $f = \frac{\omega}{2\pi} = \frac{377 \text{ rad/s}}{2\pi} = 60 \text{ Hz}$
- b. Amplitude = 5, $f = \frac{\omega}{2\pi} = \frac{754 \text{ rad/s}}{2\pi} = 120 \text{ Hz}$
- c. Amplitude = 10^6 , $f = \frac{\omega}{2\pi} = \frac{10,000 \text{ rad/s}}{2\pi} = 1591.55 \text{ Hz}$
- d. Amplitude = 0.001, $f = \frac{\omega}{2\pi} = \frac{942 \text{ rad/s}}{2\pi} = 149.92 \text{ Hz}$
- e. Amplitude = 7.6, $f = \frac{\omega}{2\pi} = \frac{43.6 \text{ rad/s}}{2\pi} = 6.94 \text{ Hz}$
- f. Amplitude = $1/42$, $f = \frac{\omega}{2\pi} = \frac{6.28 \text{ rad/s}}{2\pi} = 1 \text{ Hz}$

22. $T = \frac{2\pi}{\omega} = \frac{2\pi}{157} = 40 \text{ ms}, \frac{1}{2} \text{ cycle} = 20 \text{ ms}$

24. $1.2\pi \left(\frac{180^\circ}{\pi} \right) = 216^\circ$

$v = 20 \sin 216^\circ = 20(-0.588) = -11.76 \text{ V}$

26. $v = V_m \sin \alpha$
 $40 = V_m \sin 30^\circ = V_m(0.5)$
 $\therefore V_m = \frac{40}{0.5} = 80 \text{ V}$

$\frac{30^\circ}{360^\circ} = \frac{1 \text{ ms}}{T}$

$T = 1 \text{ ms} \left(\frac{360}{30} \right) = 12 \text{ ms}$

$f = \frac{1}{T} = \frac{1}{12 \times 10^{-3} \text{ s}} = 83.33 \text{ Hz}$

$\omega = 2\pi f = (2\pi)(83.33 \text{ Hz}) = 523.58 \text{ rad/s}$

and $v = 80 \sin 523.58t$

30. a. $v = 2 \sin(\omega t - 30^\circ + 90^\circ)$
 $i = 5 \sin(\omega t + 60^\circ)$ } in phase

b. $v = \sin(\omega t + 20^\circ + 180^\circ) = \sin(\omega t + 200^\circ)$
 $i = 10 \sin(\omega t - 70^\circ)$ } i leads v by 90°

c. $v = 4 \sin(\omega t + 90^\circ + 90^\circ + 180^\circ) = 4 \sin \omega t$
 $i = \sin(\omega t + 10^\circ + 180^\circ) = \sin(\omega t + 190^\circ)$ } i leads v by 190°

32. a. $v = 0.01 \sin(2\pi(25)t + 11/18\pi) = 0.01 \sin(157t - 110^\circ)$

b. $i = 2 \times 10^{-3} \sin(2\pi(10 \times 10^3)t + 135^\circ) = 2 \times 10^{-3} \sin(62.8 \times 10^3 t + 135^\circ)$

34. $\omega = 2\pi f = 50,000 \text{ rad/s}$
 $f = \frac{50,000}{2\pi} = 7957.75 \text{ Hz}$
 $T = \frac{1}{f} = 125.66 \mu\text{s}$
 $t_1 = \frac{40^\circ}{180^\circ} \left[\frac{T}{2} \right] = 0.222(125.66 \mu\text{s}) = 27.92 \mu\text{s}$
36. a. $T = (8 \text{ div.})(1 \text{ ms/div.}) = 8 \text{ ms}$ (both waveforms)
- b. $f = \frac{1}{T} = \frac{1}{8 \text{ ms}} = 125 \text{ Hz}$ (both)
- c. Peak = $(2.5 \text{ div.})(0.5 \text{ V/div.}) = 1.25 \text{ V}$
 $V_{\text{rms}} = 0.707(1.25 \text{ V}) = 0.884 \text{ V}$
- d. Phase shift = 4.6 div. , $T = 8 \text{ div.}$
 $\theta = \frac{4.6 \text{ div.}}{8 \text{ div.}} \times 360^\circ = 207^\circ$ *i* leads *e*
or *e* leads *i* by 153°
38. a. $G = \frac{(6 \text{ V})(1 \text{ s}) + (3 \text{ V})(1 \text{ s}) - (3 \text{ V})(1 \text{ s})}{3 \text{ s}} = \frac{6 \text{ V}}{3} = 2 \text{ V}$
- b. $G = \frac{\left[\frac{1}{2}(4 \text{ ms})(20 \text{ mA}) \right] - (2 \text{ ms})(8 \text{ mA})}{8 \text{ ms}} = \frac{40 \text{ mA} - 16 \text{ mA}}{8} = \frac{24 \text{ mA}}{8} = 3 \text{ mA}$
40. b. **0.5 V**
42. a. $V_{\text{eff}} = 0.707(20 \text{ V}) = 14.14 \text{ V}$ b. $V_{\text{eff}} = 0.707(7.07 \text{ V}) = 5 \text{ V}$
- c. $I_{\text{eff}} = 0.707(6 \text{ mA}) = 4.242 \text{ mA}$ d. $I_{\text{eff}} = 0.707(16 \text{ mA}) = 11.312 \text{ mA}$
44. $V_{\text{eff}} = \sqrt{\frac{(2 \text{ V})^2(4 \text{ s}) + (-2 \text{ V})^2(1 \text{ s}) + (3 \text{ V})^2\left[\frac{1}{2}\right]}{12 \text{ s}}} = 1.43 \text{ V}$
46. $G = \frac{(10 \text{ V})(4 \text{ ms}) - (10 \text{ V})(4 \text{ ms})}{8 \text{ ms}} = \frac{0}{8 \text{ ms}} = 0 \text{ V}$
 $V_{\text{eff}} = \sqrt{\frac{(10 \text{ V})^2(4 \text{ ms}) + (-10 \text{ V})^2(4 \text{ ms})}{8 \text{ ms}}} = 10 \text{ V}$
48. $G = \frac{\frac{1}{2}bh}{T} = \frac{\frac{1}{2}(10 \text{ ms})(20 \text{ V})}{10 \text{ ms}} = 10 \text{ V}$
50. a. $V_{dc} = IR = (4 \text{ mA})(2 \text{ k}\Omega) = 8 \text{ V}$
Meter indication = $2.22(8 \text{ V}) = 17.76 \text{ V}$ b. $V_{\text{rms}} = 0.707(16 \text{ V}) = 11.31 \text{ V}$